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colour would be somewhat similar to that of the obscure portion of the moon as enlightened by the earth? It is, however, of a totally different hue, and strongly resembles the *tarnished copper* colour frequently assumed by the moon under a total eclipse. May it not also be fairly questioned whether the ring would be so brilliantly illuminated by the reflected light of *Saturn* (which must fall but feebly on the half of the ring farthest from the sun), as to cause small portions of it to rival in brightness the satellites themselves illuminated by the direct rays of the sun: the brightest points of the ring (the eastern and western extremities) receiving reflected light from *one-half only* of the illuminated surface of *Saturn*, which would be seen from them as a *half-moon*?

"I would venture, therefore, to suggest, that the illumination of the obscure surface of the ring arises from the *refraction of the sun's light through an atmosphere surrounding each of the rings*, and thus throwing a pretty strong *twilight* upon them. During the whole time that the obscure surface was turned towards the earth, the sun was not more than two degrees below its plane; and during the period embraced by the observations, the depression scarcely ever amounted to one degree. A very moderate density of atmosphere, therefore, might suffice to produce considerable illumination of the obscure surface; much greater, probably, than the reflected light of *Saturn* could give, and of a far *ruddier tinge*, more nearly resembling that of our western sky shortly after sunset.

"3. It was occasionally observed, and on Oct. 6th it is recorded, that the dark shade on the ball was not uniformly black, its *northern* portion being *blacker* than the southern. On three unusually fine nights, viz. Oct. 26th, Oct. 30th, and Nov. 21st, this shade was seen to be divided through its whole length into two parts by an excessively fine bright line. After scrutinising the object for a long time with high powers, I remained perfectly convinced of the fact, which I can account for only by supposing that the northern and blacker portion was the shadow of the ring cast by the sun upon the ball; that the somewhat lighter shade was the ring itself seen projected upon *Saturn*; and that the bright line between the two was a portion of the equatoreal regions of the planet. The relative situations of the different bodies at the time renders, I think, such an explanation probable."

On the Past History of the Comet of Halley. By Mr. J. R. Hind.

It is well known that the periodicity of the remarkable comet which bears the name of Halley was inferred by that astronomer from a comparison of three sets of elements, calculated on observations of the comets of 1531, 1607, and 1682. When his table of cometary orbits was first published, Dr. Halley says he was content to hint at his conjectures respecting the identity of the comets of those years as having some degree of probability, and to advise pos-

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terity carefully to watch for its return about the year 1758. At a subsequent period, an examination of the catalogues of ancient comets showed that three others had preceded those already mentioned, "manifestly in the same order and at like intervals of time, viz. in the year 1305 about Easter; in the year 1380, the month unknown; and, lastly, in the month of June 1456;" and on making this discovery Dr. Halley says he became much more confirmed in his former opinion. Want of data, however, prevented his ascertaining beyond doubt that the comet of 1682 had appeared in any of the three years, 1305, 1380, or 1456, and he had little or nothing but equality of intervals on which to found his belief.

M. Pingré, after collecting together the immense mass of records from which his great work the *Cometographie* is constructed, was enabled to convert into a certainty Halley's supposition respecting the appearance of his comet in 1456. Two definite observations of the position were found, the one at Vienna, mentioned in an Austrian chronicle by Ebendorffer, the other at Rome, preserved in a manuscript treatise on the comet of 1468, to which Pingré had access in the Bibliothèque du Roi at Paris. The comet was in perihelion on the 8th of June at 22^h, Julian style.

The preceding appearance was referred by Halley to 1380, but M. Laugier has shown that it took place in the autumn of 1378, under nearly the same circumstances as in 1835. The Chinese observations fix the time of passage through perihelion on November 8^d 18^h.—(*Conn. des Temps*, 1846.)

In a paper on the history of the comet of Halley, published in the *Comptes Rendus* for 1846, July 27, M. Laugier has recognised this body in 760 and 451. The elements calculated by Burckhardt for the comet observed by the Chinese in 989 approached so close to that of Halley's Comet, that some suspicion of their identity has been entertained. But I believe, with these exceptions, the returns which I am about to mention as either certain or probable have not been previously noticed. The valuable details existing in the annals of China, and but recently known in Europe, enable us to trace this famous comet with a high degree of probability to the year 11 before the Christian era,—a most important circumstance, not only as regards the history of this particular comet, but as bearing on the constitution of these bodies in general. I shall merely state here the results to which I have been led by a close examination of the *Cometographies* and Chinese records, without extending this notice to an inconvenient length by the insertion of details. The data which I have had to work upon are found in the *Cometographies* of Pingré, Hevelius, and Lubienietski, Ma-tuoan-lin's catalogue of comets and extraordinary stars, and the other Chinese authorities with which we are acquainted through the labours of M. Edouard Biot.

The comet of Halley having returned to its perihelion in 1378, we may expect to find some mention of it about the year 1301; and notwithstanding the anomalous character of the results obtained by MM. Burckhardt and Laugier for the first comet of that year, I

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am pretty well convinced it was no other than the comet of Halley. The Chinese account, which is tolerably definite, is exceedingly well represented by the elements of that body: assuming the perihelion passage to have occurred on October 22^{d} 16^{h} Greenwich time, the comet passed through *Gemini*, south of *Ursa Major*, and finally traversed *Serpens* and *Ophiuchus*, being lost in the twilight at the end of October or beginning of November. There is one European account, however, which is not so easily reconciled with this supposition. It is that of Friar Giles, whose description has led M. Laugier to an orbit differing considerably in the position of the line of nodes from that of Halley's Comet. Now, had this Friar Giles established for himself a reputation as an exact and consistent recorder of facts, we might justly entertain serious doubts as to the identity of the comet of 1301 with Halley's; but in his account of another comet (that of 1264) he contradicts himself so manifestly in the same paragraph, that we may fairly question his ability to describe accurately what he saw. Even in the case before us there is some confusion, and M. Laugier has been obliged to admit an alteration, which produces a contradiction in Giles's account, in order to reconcile the main part of his description with the Chinese observations.

The question stands thus: Halley's Comet should have appeared in all probability about 1301. We find in that year mention of a comet whose apparent path, according to the Chinese historians, is well represented by the elements of Halley's Comet: the only objection to the identity that can be advanced rests on an observation of latitude by an European astronomer, or, rather, astrologer, whose description of another comet has been shown to contain a manifest contradiction, and who, in the very case before us, has committed one pretty decided error. I am strongly inclined to recognise in the first comet of 1301 Halley's famous star.

It will readily be understood that I have not the slightest intention to undervalue M. Laugier's investigation on this comet; there can be no doubt that if we admit the whole narration of Friar Giles, his orbit must be retained, and in that case we must conclude that the comet of Halley passed its perihelion about the year 1301, unobserved, or, at least, unrecorded.

The preceding return of the comet took place, I think, in 1223, in the month of July, shortly before the death of Philip Augustus, as French historians state. It was seen for eight days at the beginning of July in the evening twilight. The Chinese have no mention of this comet, and it unfortunately happens that European chronicles give very vague accounts of it, so that we cannot come to any definite conclusion respecting its identity with Halley's. All that can be said is, that the few particulars we possess agree perfectly well with the position of Halley's Comet in the heavens when the perihelion occurs in July, and that the comets of the preceding and following year, observed in China, appear to have had very different elements. It is therefore most likely that our comet was in perihelion in July 1223.

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In 1145 the return of the comet of Halley seems to me little less than a matter of certainty. On carrying back the elements to that epoch, and fixing the perihelion passage on April 19, the whole of the particulars left us by the European and Chinese authors are exactly represented. Its discovery in the morning twilight about April 15, its increasing brilliancy towards the end of the month, the disappearance about the first week in May, and rediscovery in the evening sky in the north-west on May 14th, and gradual fading away in *Hydra* on the 9th of June, are fully explained, the positions agreeing perfectly.

The periods of revolution between 1145 and 1456 average $77\frac{1}{2}$ years, and if we reckon backwards a like interval from 1145 we arrive at the year 1067, about which epoch we may expect to recognise the comet again.

There is vague mention in several European chronicles of the appearance of a comet at the time of the death of Constantine Ducas, in May 1067. We have no particulars, and even the reality of the comet is subject to some doubt. In 1066, a year memorable in English history as that of the Norman Conquest, a very grand and remarkable comet is recorded by nearly every chronicler and historian of the age. It was observed throughout Europe and China during the months of April and May. The elements of Halley's Comet, as they at present exist, will hardly represent these circumstances with a sufficient degree of accuracy; but if we assume the following numbers we shall have a very fair agreement between observation and calculation :—

Perihelion Passage 1066, April 1^d 0^h, Greenwich Time, Julian Style.

	°	′
Longitude of Perihelion	264	55
Ascending Node	25	50
Inclination......................	17	0
Least Distance	0	72

Motion Retrograde.

In this orbit the longitude of perihelion is further in advance than that of the present orbit of Halley's Comet by 30°, and the node by 17° : the perihelion distance is greater by 0·14. But are these differences to be considered beyond the limits of probability? in the lapse of so many centuries may not the planetary perturbations have produced alterations in the elements at least equivalent to those here exhibited, especially since there is good reason to conclude that the plane of the orbit of Halley's Comet formerly coincided much more closely with the plane of the ecliptic than at present, the comet being, therefore, subject to far larger perturbations than it has undergone in more recent times?

The elements which I have assumed for the comet of 1066 have been obtained partly from the observations in that year and partly from the Chinese description of a comet A.D. 141, which also agrees with the supposed period of Halley's. The *same orbit will represent the apparent paths in both years;* and I would particularly insist on this point as one of some importance in the present inquiry.

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I may also remark, that it appears by no means improbable that an orbit more closely resembling that of Halley's Comet might be made to represent the circumstances recorded of the comet of 1066 with tolerable accuracy. The descriptions of this object are so confused that a good deal of uncertainty is necessarily attached to any conclusion we may deduce from the observations.

The preceding return of Halley's Comet took place, I think, in 989, and Burckhardt's calculations relative to the comet observed in China in that year strongly support this idea. The perihelion passage would occur about the 12th of September.

In 912 a comet was seen in China in the month of May in *Leo*, near the star marked χ on our charts. It was also perceived in Europe. The orbit of Halley's Comet, with very trifling alterations, will agree with the above position about May 13 or 14, if we fix the perihelion at the beginning of April.

The preceding appearance of the comet should fall about 837, in which year a most splendid comet was observed both in Europe and China. The elements of this body, calculated by Pingré, exhibit a general similarity to those of Halley's Comet, with the exception of the node, which is almost diametrically opposite. Now Pingré conjectured, as he himself states, that the comet passed the *ascending* and not the *descending* node on the 10th of April, or otherwise it could hardly be said to move in a north-west direction on the 12th, as we learn from the Chinese relation. It is clear, from the position of the tail on the former date, that the head of the comet could not have been far from the ecliptic; and it appears to me that Pingré's conclusion is unavoidable, if we take into consideration the whole of the Chinese description, notwithstanding its laxity as regards the distances of the comet from the equator and the singularity of the circumstance that a comet should have become visible in the very year when Halley's would probably return to the perihelion, presenting in every element except the node a striking resemblance to the orbit of that interesting body. The comet of 837 which figures in our catalogues was, therefore, in all probability, different from Halley's, though the position and distance in perihelion and direction of motion were the same, and the inclination of the orbit (a most uncertain element in the present case) not very widely different for the two bodies.

The Chinese annals mention another comet in May and June 837, which was probably that of Halley. It is not unlikely that successive copyists have altered the original description of the path amongst the stars, and that the comets observed in *Gemini* and *Virgo* in these months were the same. For the Chinese accounts of the apparent tracks of comets present frequent instances of want of chronological arrangement: thus, a date is occasionally mentioned as the epoch of discovery, and a position corresponding to a subsequent time immediately follows. If we may interpret the Chinese description, so as to place the discovery of Halley's Comet in *Gemini* on April 29, and to refer the positions in *Leo* and *Virgo* to that body at a subsequent date, it will be easy to reconcile the

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apparent path with calculation, supposing the perihelion passage to have occurred early in April.

If the comet of *Gemini* and *Leo* was not that of Halley, probably this object was missed altogether at this return.

M. Laugier has shown in the most satisfactory manner that the observations of the comet of 760 in Europe and China are perfectly represented by the orbit of Halley's Comet, the perihelion falling on June 11. This year accords with my intervals. The return of the comet in 760 appears to me little short of a certainty.—(*Comptes Rendus*, 1846, July 27.)

In September and October 684 a comet was seen in China in the western heavens; but no further particulars are given. If Halley's Comet reached its point of least distance from the sun in October, it might have been observed in this position in September and the early part of October.

The previous return should have taken place about the year 607, and the Chinese annals have several comets in that year. I find, by actual computation, that none of them present any decided indications of identity with the one which forms the subject of these remarks, and I am therefore inclined to fix its reappearance in the following year, 608, when a comet is mentioned by Matouan-lin, though (most unfortunately) he has omitted to state the days to which his positions apply. The path attributed to this body, from *Auriga*, through the lower part of *Ursa Major*, into *Scorpio*, where the comet vanished, is precisely that which Halley's Comet must follow when the perihelion takes place in October or early in November. This circumstance, and the close agreement of intervals, appear to render it highly probable that the Chinese observed the comet of Halley in 608.

After a careful examination of the particulars related of the comets of 530 or 531, which Newton and Halley, owing to the want of precise data, recognised as that of 1680, I find the whole of them may be explained by the elements of Halley's Comet, supposing it to have been in perihelion early in November. Yet this inference is necessarily open to considerable doubt, and I am very far from insisting upon it. Of one point I have become pretty well convinced by my calculations, viz. that the comet of 530 or 531 (for the year of appearance is doubtful) was not identical with the celebrated one of 1680. Pingré seems to have suspected this, though he has endeavoured by alteration of dates or positions to show that such identity may have been possible. Where, however, we find the accounts of a comet as they stand in the original authorities reconcilable with a single orbit, it is surely unfair to alter them in any way, so as to produce an agreement with some preconceived notions.

In 451, or at an interval of about 79 years from 530, a comet was observed in Europe and China. It appeared about the time of the Battle of Chalons, when Attila was defeated by the Roman General Aetius. On May 17 the Chinese saw it near the *Pleiades*, and followed it till July 13, when it was situate near *β Leonis*.

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Assuming Halley's Comet to have arrived in perihelion on July 3 at midnight, M. Laugier finds a remarkable agreement between the observed and calculated positions, and there can remain but little doubt that this body was seen in 451.

Seventy-eight years previous, or in October 373, 24th day, the Chinese mention a comet in *Ophiuchus* and *Serpens*. Suppose our comet to have been at its least distance from the sun early in November, we shall find it would be located in *Ophiuchus* on the 24th of October. The account is too vague, however, to allow of any definite conclusion.

Deducting another period of 78 years, we arrive at the year 295, and at this epoch I find recorded a comet in Ma-tuoan-lin's catalogue which has every appearance of identity with Halley's. The path assigned by this historian is exactly represented by the orbit of Halley's Comet, assumed to be in perihelion at the commencement of April. It passed through the lower part of *Ursa Major*, *Leo*, and *Virgo*, having been previously seen with the same right ascension as the constellation *Andromeda*. A comparison of the track in 295 with the paths followed by the comets in 451, 760, and 1456, will sufficiently justify the inference that the observations of the year 295 really belong to the comet of Halley.

Another interval of 77 years from this epoch brings us to the year 218, when this famous body should have visited us again, and it is an important fact that the Chinese annals mention a comet in 218, which there can scarcely be a doubt was the one in question. It was seen also in Europe shortly before the death of the Emperor Opilius Macrinus, who was killed on the 7th of June. Dion Cassius describes it as a very fearful star, and the Chinese tell us it was intensely brilliant. It passed through *Auriga*, *Gemini*, *Ursa Major*, into *Leo*, but was observed first in the morning in the eastern heavens. I fix the time of perihelion passage of Halley's Comet on April 6th, and find every circumstance recorded of the comet of 218 faithfully represented.

The preceding return fell, I think, in the year 141, and a fine comet is referred to that year by the Chinese historians. It was seen first in *Aquarius* and *Pegasus*, in the morning sky, about March 27, and about three weeks subsequently became visible in the evening, traversing *Taurus*, *Gemini*, *Leo*, &c. The elements of Halley's Comet, unaltered, do not quite agree with this track and the dates attributed to the various positions; but if we suppose the following orbit, depending on the observations of 1066 and 141 (as already mentioned), we shall have a very fair agreement:—

Perihelion, March 29·1.

	°	′	
Longitude of Perihelion	251	55	Equinox of 141.
Ascending Node	12	50	
Inclination................	17	0	
Least Distance	0	72	

Motion Retrograde.

These elements have great resemblance to those of Halley's Comet, and it is very likely that an orbit differing still less might

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suffice to produce a tolerable agreement. But few comets are recorded about this year, and none of them exhibit any indications of identity with Halley's, except that of 141.

In the catalogue of Ma-tuoan-lin we find a comet in the year 65, and another in 66, either of which may possibly have been Halley's, though I think the latter agrees better on the whole. It was discovered in January in the eastern heavens; on February 20 it had the same right ascension as the star β in *Capricornus*, and advanced to the south of *Scorpio*. These circumstances are in perfect accordance with the track followed by Halley's Comet when the perihelion passage takes place on January 26th.

The few particulars we have respecting the comet of A.D. 65 may be represented by the orbit of Halley's Comet, admitting it to have reached the perihelion on August 5th. It is possible, therefore, that the sword-shaped sign that was seen over Jerusalem at the commencement of the war which ended in the destruction of the Holy City by Titus, may have been the comet of Halley.

The most ancient, and, at the same time, one of the most certain apparitions of this body, took place in the year 11 B.C., reckoning according to the manner of astronomers. It was observed, according to Dion Cassius, under the consulate of M. Messala Barbatus and P. Sulpicius Quirinus, before the death of Agrippa, and seemed as though it were suspended over the city of Rome. The Chinese found it on the 26th of August in *Gemini;* it passed over this constellation, north of *Castor* and *Pollux*, towards *Leo* and *Virgo*, moving at the rate of 6° daily. Subsequently it passed near *Arcturus* and other stars in *Boötes* and arrived in *Ophiuchus* and *Serpens*. Fifty-six days after, August 26th, it set with π and σ *Scorpii*.

After the publication of M. Biot's valuable details in the appendix to the *Connaissance des Temps* for 1846, I attempted an orbit for this comet, and was immediately struck with the similarity of the elements to those of the comet of Halley. The only alteration necessary appeared to be a diminution of the orbital inclination, which, instead of 17°, would be more satisfactory at 8° or 10°. The Chinese description cannot be strictly followed, or we should have a very irregular path; but I am satisfied that the elements of Halley's Comet for perihelion, node, and least distance, and an inclination of 8°, will accord as well with the observations as any orbit can possibly do.

Previous to the year 11 B.C. the accounts of comets become so vague that it would be vain to attempt to carry the inquiry into more remote antiquity. I think it will be deemed a fact of considerable interest that the celebrated comet which bears the name of our countryman Halley may be traced, in a pretty satisfactory manner, as far back as the year 11 before the Christian era. For this extensive knowledge of its probable history we are mainly indebted to the records preserved in the annals of the various reigning dynasties in China.